Indian J. Plant Physiol., Vol. XXXV, No. 2, pp. 152-156 (June, 1992)

EFFECT OF HIGH TEMPERATURE STRESS ON DRY MATTER DISTRIBUTION—ITS RELATION WITH INTERNODE ELONGATION AND GIBBERELLIN CONTENT IN *SOLANUM TUBEROSUM*

SHANTHA NAGARAJAN* AND RAKESH BHARGAVA

Central Potato Research Institute, Shimla—171 001

Received on 26 Nov., 1991

SUMMARY

There was a general reduction in dry matter distribution in tubers and roots in all the genotypes under heat stressed condition. The heat tolerant genotypes, however, partitioned more dry matter towards tuber and roots compared to susceptible ones. Also the proportional increase in mean internode length in heat stressed plants was more in tolerant genotypes as compared to susceptible ones.

INTRODUCTION

High temperature is known to reduce tuber yields in potato through reduction in the assimilate supply as well as its reduced partitioning to tubers (Slater, 1968; Saha *et al.*, 1974). It also results in smaller leaves, longer internodes and more axillary branches (Ewing and Keller, 1982). Our earlier study with a heat susceptible cultivar had shown the significant differences in morphological characters induced by high temperature (Nagarajan and Bansal, 1990). The present study was aimed to identify suitable morphological traits for heat tolerant genotypes and to compare them for partitioning of assimilates under high temperatures in known tolerant and susceptible genotypes. As increased production of gibberellin has been associated with high temperature (Menzel, 1983), therefore the GA like activity was also estimated in the young leaves and buds of two tolerant and two susceptible genotypes grown under normal and high temperatures.

MATERIALS AND METHODS

Out of six potato genotypes chosen for this study, Desiree, LT-1 and HC-294 were heat tolerant, Kufri jyoti and Kufri chandramukhi were susceptible and

* Present address; Nuclear Research Laboratory, I.A.R.I., New Delhi.

Phulwa was a moderately tolerant cultivar. The plants were raised in earthern pots (22 cm dial) using sand and hill soil rich in farm yard manure in the ratio of 1:1. At 2-3 leaf stage, half of the pots were transferred to a glass house having temperatures of 38°/22°C day/night. The other half were kept in the greenhouse with optimum temperatures of 26°/18°C day/night.

Plant height, number of nodes and axillary branches were recorded at 10 day interval in normal and high temperature exposed plants. At three stages of growth, namely, before and after tuberization, and at tuber bulking stages, five randomly selected plants were uprooted. After washing the roots, fresh and dry weights of leaf, stem, root with stolons and tubers were recorded. For gibberellin estimation two known heat tolerant cultivars (LT-1 and Desiree) and two known susceptible cultivars (Kufri Jyoti and Kufri Chandramukhi) were taken. One hundred gramme leaf sample from top four leaves including the terminal bud was macerated in cold ethanol and the gibberellin content was estimated following lettuce hypocotyl bioassay technique (Barnes and Foong, 1979).

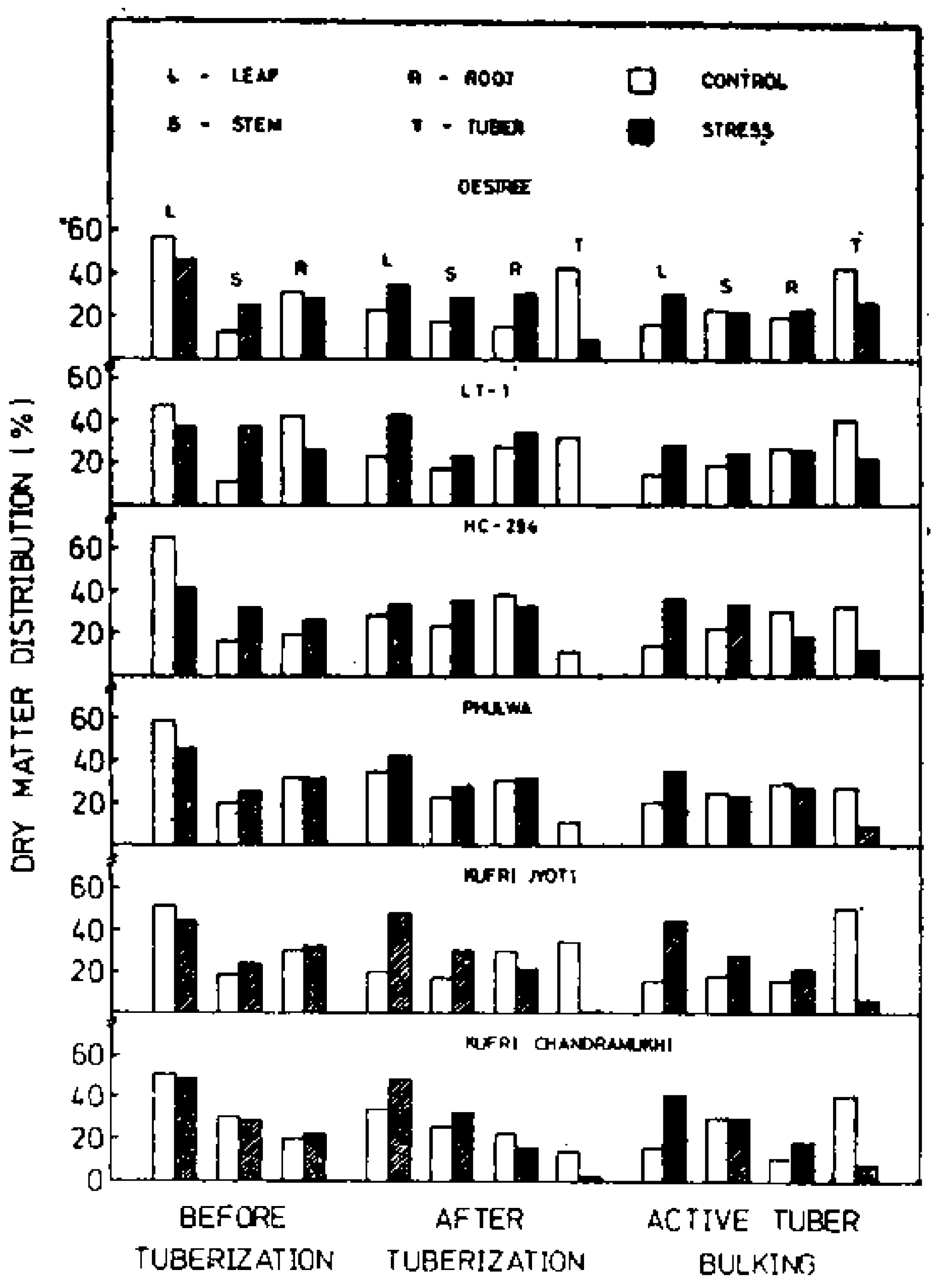

Fig. 1. Per cent dry matter distribution in different plant parts of heat stressed and unstressed plants in six potato genotypes at three growth stages.

RESULTS AND DISCUSSION

The distribution of total dry matter in leaves, stem, root with stolons and tuber has been given on percentage basis (Fig. 1). Before tuberization no noticeable change in dry matter distribution could be recorded in stressed and unstressed plants in case of susceptible cultivars (Kufri jyoti and Kufri chandramukhi), whereas in tolerant genotypes, dry matter partitioning was more in stem in heat stressed plants. After tuberization, more dry matter was retained in the shoot of all the cultivars under stress condition. However, the tolerant genotypes (Desiree and LT-1) got adjusted to the adverse condition. Phulwa and HC-294, though not susceptible to high temperatures. performed poorly both under optimal and heat stressed conditions.

The number of axillary branches increased under high temperatures, although no relationship with the heat tolerance could be established (data not given). The per cent increase in mean internode length was more in Desiree, LT-1 and HC-294

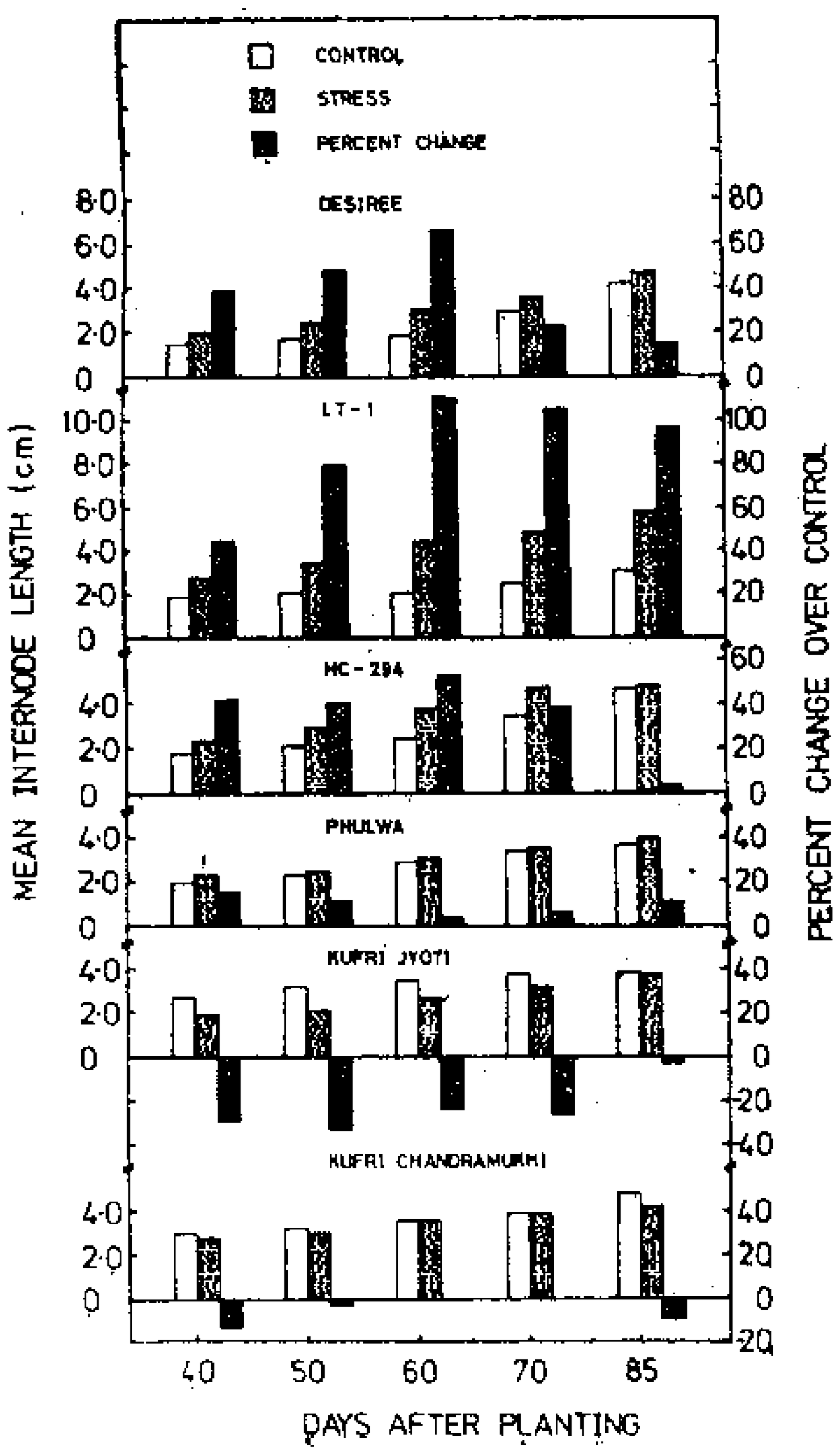

Fig. 2. Mean internode-length of heat stressed (38/22°C) and unstressed (26/18°C) potato plants of six genotypes and the per cent change over controls at different growth stages.

Table-I. Effect of temperature on gibberellin content in the top four leaves of potato plants after tuberization as determined by lettuce hypocotyl bioassay

Genotypes	Gibberellin content (μg GA_3 equivalent per kg.f.wt.)	
	Control (26/18°C)	Stressed (38/22°C)
Kufri Jyoti	30.3	5.2
Kufri Chandramukhi	33.0	3.1
Desiree	12.8	24.8
LT-1	17.0	28.2
L.S.D. (P=0.05)		10.2 (Log transformed)

and was negative in Kufri jyoti and Kufri chandramukhi (Fig. 2). In Phulwa, though the per cent increase was small, it was positive.

The GA level in the shoots of tolerant cultivars increased by 80% at high temperature compared to control whereas, a reduction of 87% was noted in the susceptible ones. In spite of higher levels of GA, the tolerant ones were able to produce more tubers than the susceptible ones at higher temperatures. It has been reported (Anon, 1979) that in the shoots of heat adapted clones of DTO-28, the GA_3 activity was more than non-adapted variety Maria. The higher levels of GA in the shoots of LT-1 and Desiree probably explains the higher internode elongation in these cultivars under heat stress condition when compared to Kufri jyoti and Kufri chandramukhi. But this needs further confirmation in a large number of genotypes.

ACKNOWLEDGEMENT

The technical help provided by Snri J.S. Jassel is gratefully acknowledged.

REFERENCES

Anonymous (1979). Physiological and agronomic management of potatoes adapted to environmental stress. Annual Report, Int. Potato Center, Lima, Peru. pp. 49-58.

Barnes, M.F. and Foong, J.W. (1979). The interaction of abscisic acid with gibberellic acid in the lettuce hypocotyl bioassay. *Pl. Sci. Lett.*, 17 : 51-53.

Ewing, E.E. and Keller, K.R. (1982). Limiting factors to the extension of the potato into non-traditional climates. Proc. of the International Congress 'Research for the potato in the year 2000'. International Potato Center, Lima, Peru (Ed. W.J. Hooker), pp. 37.

Menzel, C.M. (1983). Tuberization in potato at higher temperatures : Gibberellin content and transport from buds. *Ann. Bot.*, **52** : 697-702.

Nagarajan, S. and Bansal, K.C. (1986). Measurement of membrane thermostability to evaluate foliage heat tolerance of potato. *Potato Res.*, 29 : 164-167.

Nagarajan, S. and Bansal, K.C. (1990). Growth and distribution of dry matter in a heat tolerant and a susceptible potato cultivar under normal and high temperature. *J. Agron. & Crop Sci.*, **165** : 306-311.

Saha, S.N., Murthy, G.S.R., Banerjee, V.N., Purohit, A.N. and Singh, N. (1974). Effect of high temperature on growth and development of Indian potato varieties under short day conditions. *Ind. J. Agri. Sci.*, **44** : 376-382.

Slater, J.W. (1968). The effect of high temperature on tuber initiation of potato. *Eur. Potato J.*, **11** : 14-23.